# MODELING OF SOIL AQUIFER TREATMENT PROCESSES USING A MULTI-DIMENSIONAL SUBSURFACE FLOW AND REACTIVE TRANSPORT MODEL

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Soil Aquifer Treatment (SAT) is a technology for water reuse in which the secondary or tertiary treated wastewater percolates through the unconfined or confined aquifer using various physical or biochemical soil processes. A major concern in SAT systems is the fate and transport of organic compounds during the infiltration of treated wastewater to the groundwater. A secondary concern is the nitrogen species that include ammonium and nitrate (NCSWS, 2001). Few mathematical models exist to simulate SAT processes. A 3-dimensional SAT model was developed to evaluate factors affecting the performance of SAT systems: (1) characteristics of the treated wastewater, which is the source water in a SAT system, (2) physical characteristics of the aquifer, and (3) features of operational cycle which includes both wet and dry periods. The model accounts for reactions including the nitrification of ammonium ion, the denitrification of nitrate, and the oxidation of organic carbon in variable saturated porous media. Concentrations of dissolved oxygen and biomasses involved in aerobic and anaerobic biological reactions are taken into consideration to precisely estimate the nonlinear reaction rates formulated using a multiple-Monod expression.

Simulations using a two-dimensional cross-sectional domain, with unsaturated and saturated zones, were conducted to examine the effects that site and operational conditions have on the performance of a SAT system. Figure 1 presents profiles of water saturation and ammonium ion, nitrate, DOC, and oxygen concentrations at 25, 50, 100, 140 days. Cycling in the source water loading affects the water saturation distribution under the source zone. The infiltrating water reaching the water table is mainly composed of nitrate indicating complete DOC removal, ammonium nitrification, and incomplete denitrification as indicated by others (Tang et al, 1996). Thus, only the nitrate plume in the saturated zone grows continuously over time. The behavior of dissolved oxygen plume is more dynamic than other species depending on the operation stage. During the drying period, dissolved oxygen concentrations, depleted by nitrification and DOC oxidation, are replenished from the surface and by incoming groundwater from the left boundary which is assigned a constant dissolved oxygen concentration. However, the region of oxygen depletion is only partially recovered in each 7-day dry period.

Overall, the simulation results showed that organic carbon was effectively removed and that the availability of oxygen was a key factor in predicting the production and removal of nitrate. Overall, the model successfully described the fate and transport of the key constituents during the wet/dry operation periods in both unsaturated and saturated subsurface environments. The model developed in this study can also be used to simulate

flow and transport processes in bank filtration technique.

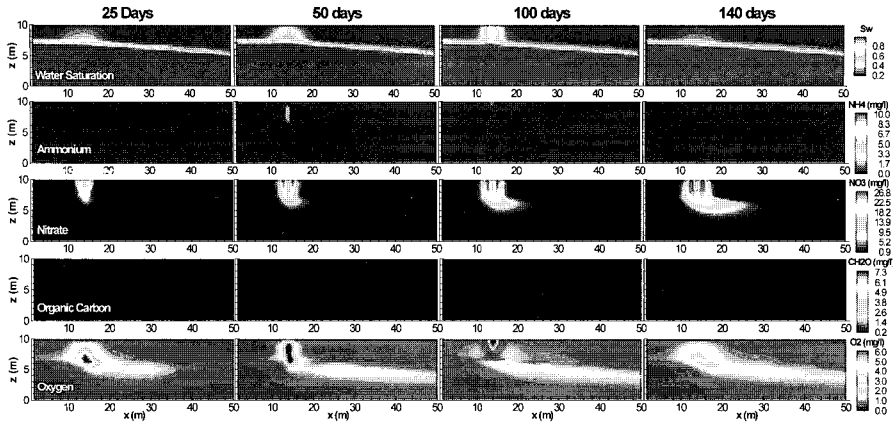


Fig. 1 Profiles of water saturation and ammonium, nitrate, DOC and oxygen for Case 1.